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"To promote the cause of fish culture; to gather and diffuse information bearing upon its practical success, and upon all matters relating to the fisheries; to unite and encourage all interests of fish culture and the fisheries; and to treat all questions of a scientific and economic character regarding fish."

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CONTENTS

THE SHAD—A NATIONAL PROBLEM

By Charles Minor Blackford, M.D., *Staunton, Va.*

Among the many blessings bestowed by nature on North America, the almost infinite wealth of its sea and inland fisheries takes high rank. The famous fisheries of the North Sea become almost trivial when compared with those of our Atlantic coast; the much vaunted salmon streams of Norway and Scotland become merely sportsmen's playgrounds when compared with the Columbia and others of our Pacific streams, and probably no equal area of water in the world is as prolific in fishery products as is Lake Erie. From the bayous of the Gulf to the tributaries of Hudson Bay, the two species of black bass abound, while the charrs of the east and the trouts of the west afford game to anglers from ocean to ocean. The gourmand familiar with the flavor of our American fishes, finds the whitebait of the Thames or the other far-famed delicacies of Europe insipid, for there are no fishes of the old world that can bear comparison with the red snapper and the pompano of our southern shores; the blue fish, the weak fish, the Spanish mackerel and the "spot" of the Middle States, or the hake, the haddock and the cod of more nothern waters, to mention only a few of the better known products of the harvests of our seas. Without disparaging these or the equally luscious fishes of the Great Lakes and the Pacific, it may be safely said that the veritable king of food fishes is a denizen of our waters, for there is probably no fish on earth that surpasses the shad in all the qualities that go to make up an ideal food fish.

The true shad is a member of the great herring family, and it may be claimed as essentially an American fish. It has a near relative in European waters called the "Maifisch", but this latter is so inferior to its American cousin that it cannot be considered as in the same class except zoologically. In America, there are several fishes

that bear the name, but they differ from the true shad, and, in strictness, the name should be given only to the anadromous species frequenting the coastal waters and streams of the Atlantic and their immediate descendants on the Pacific side. In the waters tributary to the Gulf of Mexico, are several species, such as the Alabama shad and the Ohio shad, whose origin is uncertain. They may have come from those planted by the United States Fish Commission in southern waters, or they may be independent species. There are some fishes commonly known as shad, that are not herrings at all, such as the gizzard or hickory shad (*Dorosoma cepedianum*), the mackerel shad (*Decapterus macarellus*) and in some places even the common white fish is known as the Lake Champlain shad. The tendency on the part of people to carry familiar names into new regions is seen very plainly in the names given to new plants and animals, and the various fishes known locally as trout, salmon, shad and the like, show how little the common names can be trusted to show true relationships. The present paper will give no attention to these namesakes, however, for the true shad, *Alosa sapidissima*, is the one whose preservation has become a national problem.

The natural history of the shad is but slightly known. In the early winter the spawning fish appear in the waters of Florida, and as the season advances, they enter the streams of the more northern regions, seeking the headwaters where they spawn. This migration seems to be dependent on the temperature, for a cold spring will markedly delay their appearance in a given stream, but this is about all that is known in regard to it. There is some reason to believe that the fish do not migrate along the coast, but come directly in-shore from deep water beyond the continental plateau, but as nothing is known of their pelagic existence, this is uncertain. The shad usually appear in the Chesapeake Bay and its tributaries in April and May. In June they are apt to be found on the New England coast, and then their run is over. On the Pacific coast, Mr. N. B. Scofield of the Cali-

fornia Fish and Game Commission, reports that they enter the Sacramento and San Joaquin rivers during April, May and June. Evermann and Goldsborough* report that one was taken at the cannery at Fairhaven, Alaska, about July 1, 1903, and the species has been reported from Kussilof, on Cook Inlet. However the fish presents the curious anomaly of being a sea fish known only in fresh or brackish water, for absolutely nothing is known of its life history except at the spawning time.

The female shad is decidedly larger than the male, and to this characteristic, as well as the fact that the female contains the roe, is due the decline in the number of females as compared with the males. A net with a mesh 6 1-2 inches square will permit most of the males to pass, while it will take most of the ripe females. The mature males taken in the fisheries of the Atlantic coast will weigh from 1½ to six pounds, averaging about three pounds; while the females will run from three to six pounds, the average of both sexes being a little below five pounds. Stories have come down from the early days of the fishery of shad weighing 11, 12, and even 14 pounds, but if these ever existed they are no longer found; nine pound shad being now very rare, and ten pound fish being about the maximum. Somewhat larger fish are reported from the Pacific side where they occasionally attain a weight of some fourteen pounds and many are taken that weigh from nine to twelve pounds. Within the past few years, fish of this size have grown more rare, and no doubt they will soon come to the level of the Atlantic shad.

The decline in the size of the fish taken has been accompanied by a decline in the number of fish comprising the catch until the matter has become of national concern. In the early days of American history, the fisheries played a large part in the sustenance of the people, but shortly after the Civil War this resource had dimin-

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*B. W. Evermann and E. L. Goldsborough. The Fishes of Alaska. Bulletin of U. S. Bureau of Fisheries, 1906, page 234.

ished so markedly that Congress took action in regard to it. Several of the states had appointed commissions to care for the fisheries of those particular states, but the American Fish Culture Association—the predecessor of our American Fisheries Society—urged the establishment of a national bureau to enquire into the condition of the food fisheries of the United States and to take steps toward their improvement. The great falling off in the shad catch was the main reason advanced for this action, so in 1871 an act was passed creating the office of Commissioner of Fish and Fisheries and directing this officer to prosecute inquiries with the view of ascertaining whether there had been a diminution in the number of food fishes of the coast and lakes of the United States, and, if so, to what causes the same was due and what steps should be taken to check the decline. It was further provided that the Commissioner should be a civil servant of the Government, of proved scientific and practical acquaintance with the fishes of the coast, and that he should serve without additional compensation. Though no name was mentioned in the act, this meant but one man, and Spencer Fullerton Baird, then Assistant Secretary of the Smithsonian Institution, received the appointment and continued to fill the post until his death in 1887. The collection of statistics as to the fisheries and the conclusions drawn from them, led directly to the artificial propagation of the more valuable food fishes, and to the success attained by the United States Commission of Fish and Fisheries and its successor, the Bureau of Fisheries, in fish culture, is due very largely the fact that our principal food fishes, and especially the shad, have not become extinct.

Although it is familiar to all the members of this Society, a review of the life history of the shad is necessary to understand the present situation. The shad is an anadromous fish, and is hatched from eggs deposited far up in the headwaters of the streams. Distance seems to make little or no difference to the spawning fish, pro-

vided no impassable obstacle intervenes. Stevenson* says that in the early part of the nineteenth century, the shad ascended the Savannah River to Tallulah Falls, a distance of 384 miles, instead of 209 as at present. In the James River their former run was some 350 miles in length; the fish going far beyond Lexington, and old deeds now on record in Rockbridge and other mountain counties, specify whether the right to take shad in the rivers running through farms passed with the land. The present run of shad in the James ends with Boscher's Dam at Richmond, 120 miles from the sea, and instead of the fish being so plentiful as to be called "food for injuns and niggers," it has become one of the most costly delicacies of the table. Still more marked is the decrease in the Susquehanna, in which the shad formerly ran to Binghamton, 513 miles by watercourse from the sea, whereas now they do not appear to pass beyond Clark's Ferry, about 84 miles from the mouth of the river. In twenty-three of the principal Atlantic coast rivers, aggregating 8,113 miles in length, shad were formerly found throughout 6,052 miles while they are now found in only 4,107 miles; a decrease of nearly 2,000 miles. Colonel Marshall McDonald, a former U. S. Commissioner of Fish and Fisheries, stated that the shad catch from the 250 miles of James River from which they are now excluded, was far in excess of the total catch from that stream at the time when he made the report (1880); and much the same condition obtains in the other shad streams of the Atlantic coast.

I do not propose to burden you with a mass of statistics, but a few figures will show the gravity of the condition and may cast some light on the causes that have produced it. According to Statistical Bulletin No. 339 of the U. S. Bureau of Fisheries, the catch of shad in Virginia and Maryland in 1880 aggregated 6,946,379

*The Restricted Inland Range of Shad Due to Artificial Obstructions and Its Effect on Natural Reproduction. By Charles H. Stevenson, of the U. S. Fish Commission. Paper read before the National Fishery Congress and published in the Bulletin of the U. S. Commission of Fish and Fisheries for 1897.

pounds, valued at $275,422; in 1907, this had risen to 17,329,037 pounds, valued at $463,813, while in 1915, the catch aggregated but 6,168,669 pounds though it was valued at $849,527. Within thirty-five years the value of the catch had increased nearly four hundred per cent for approximately the same quantity, while after a decided increase, the catch declined nearly sixty per cent during the eight years from 1907 to 1915, though its money value had nearly doubled. The tremendous catch of 1907 was due in part to an unusually large run of fish, but mainly to increased zeal in fishing, as a result of which larger numbers are taken and the number of fish allowed to spawn is correspondingly diminished. With a diminishing supply, the price has advanced and still greater energy put forth in taking the fare, so that the same vicious circle is established that has led to the practical extermination of the sea otter, the fur seal, the whale and the bison. The sturgeon is going the same road, and with these examples before us, it is time that some steps be taken to preserve the shad from a like fate.

That this condition is not confined to the Chesapeake Bay is shown by the fact that the catch of shad in the Hudson River in 1915 in the two states of New York and New Jersey together, amounted to 15,855 fish, weighing 68,668 pounds, and valued at $8,643, while in 1916, there were taken 9,287 fish, weighing 40,173 pounds, and worth $5,465. On the Pacific side the first stage of this disastrous progress is well under way, for "the catch of shad has been increasing greatly the past few years, not because there are more shad, but because of the Chinese demand for salt shad, and the later demand for canned shad and for the fresh fish in the eastern markets. The run is in fact decreasing, and was this year estimated at about sixty per cent of the average run."* Since the same condition obtains on both coasts it is not therefore an exaggeration to call this a national problem.

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*Personal letter from N. B. Scofield, of the California Fish and Game Commission, dated September 9, 1916.

The causes of this decline come under two heads: first, the depredations of natural enemies, and second, the agency of man. The fishermen are prone to attribute a much larger share to the first cause than the facts justify, for although the shad have many and voracious natural enemies to prey on them, there is no reason to believe that these enemies are increasing either in numbers or in their power for evil. They inflict much injury, it is true, for "from their birth to their return to the rivers shad are preyed upon incessantly by other fish, so that the larger portion of the young do not survive their few months sojourn in fresh water, and of those which leave the rivers each season probably not one in one hundred reaches maturity to deposit its eggs and contribute to the perpetuation of its species. In the rivers, striped bass, white perch, black bass, and other predacious fishes devour the young, and when they reach salt water, sharks, horse mackerel, kingfish, etc., undoubtedly destroy many adults. It has been observed by North Carolina porpoise fishermen that as the shad swim close along the shore the porpoises follow and feed on them until they pass into fresh water."* This condition is, however, a part of the established economy of nature, and there is some reason to believe that these dangers are diminishing rather than increasing. At all events these natural enemies are not new, and they do not account for the decided decline in the numbers of the shad within the past few years.

This brings us to the consideration of the effects of human agency in the destruction of the fish, and these fall under the two heads of the destruction of the adults and the prevention of spawning. The latter is by far the more injurious. A well developed female will deposit some 200,000 eggs, and if only a small proportion of these be impregnated, hatch and grow to adult age, the supply will be readily maintained. The mere destruction of adult fish will have little or no effect on the

*Manual of Fish Culture Based on the Methods of the United States Commission of Fish and Fisheries. Washington, 1897. Page 136.

supply provided that spawning be uninterrupted. Huxley* said in regard to the herring fishery, that "The best thing for governments to do in relation to the herring fisheries is to let them alone, except in so far as the police of the sea is concerned. With this proviso, let people fish how they like, and when they like. There is not a particle of evidence that anything man does has any appreciable influence on the stock of herrings." This is unquestionably true as regards the herring or any other pelagic fish, for the human race is merely one more enemy and one whose depredations are trivial compared with those already existing in nature, but it is not true in regard to the shad. As they are only taken when on the way to the spawning grounds, the destruction of each one—and especially each female—involves the loss of a large number of possible offspring, and unfortunately it is the females that are mainly sought. Shad roe is a delicacy that commands a high price, and, as stated above, nets that will allow the males to pass will retain the females. As a result the bucks outnumber the roe shad tremendously and in a ratio that is steadily increasing. On the Pacific side last year, the ratio was about twenty bucks to one female, and this year the ratio was about thirty to one. In California and in New York efforts at artificial culture were almost total failures because of the inability to procure eggs, and this in turn was due to the scarcity of the roe fish. The increasing scarcity of the fish is stimulating the brain of man to devise more efficient means of taking them and thus quickening the extermination of the species. In the Chesapeake Bay, the nets extend out, in some cases, to a distance of twelve miles from shore, and the only chance that the fish have to get to their spawning grounds is to keep within the ship channels which are kept clear by the federal authorities. As was well put by the United States Commissioner of Fisheries, a knowledge of the federal navigation laws will soon be essential for the self preservation of the shad.

*T. H. Huxley. Popular Science Monthly for August, 1881.

Next to this over-fishing, the most important factors in the destruction of the shad are the erection of dams which debar them from their spawning grounds, and the reckless pollution of the streams. In regard to the building of dams to furnish power, it may be said that the production of power for mills, factories and electricity is more important than the conservation of a fishery, and much force lies in this plea, but there is nothing that can be said in favor of stream pollution. Not only does this destroy a valuable food resource by killing the fishes in the streams, but it imperils the lives of all who live along the streams, and in many instances the polluting material is a sheer waste of substances that could be used. But a few years have passed since laws were enacted to prohibit gas works and oil refineries from throwing their refuse into streams. This prohibition led these plants to seek modes of utilizing their waste material, and now many of these by-products are as profitable as were the primary output. Millions of tons of sewage that has great fertilizing value are annually thrown away by our towns and cities with no result save the endangering of health and the destruction of the fisheries. The only excuse is that it is a convenient mode of disposal, but this argument would permit the use of the streets as a place of deposit for the dirt from abutting houses. The waste matters thrown into the streams fills up the interstices in which fish eggs would have been deposited and thus mechanically interferes with laying the spawn. It favors the growth of bacteria that may cause diseases among the fishes, and in the process of its decay it robs the water of oxygen and replaces it with carbon dioxide and other poisonous gases while filling the water with toxins that endanger all animal life. The stupid folly of our governing bodies in permitting these conditions to continue is almost beyond belief.

The only means available at present of offsetting these destructive agencies is by artificially hatching shad fry; a process that is not difficult of accomplishment. It is almost too late for this means to be used, however, be-

cause of the great and increasing difficulty in getting the eggs. According to the statement of Dr. Tarleton H. Bean, than whom there is no higher authority in America, it was possible to collect but a million eggs in the Hudson this year, though only a few years since nearly eight millions were taken around Tivoli and Germantown, and forty years ago it was easy to get ten milions in a season at Castleton, only ten miles below Albany. As stated earlier in this paper, efforts at artificial culture in California failed because of a lack of ripe females, and it is necessary for prompt and energetic action to be taken by the various States and by the Federal Government if the shad is not to repeat the history of the Great Auk and be a monument to man's stupid ruthlessness.

THE FISHERIES OF THE CHESAPEAKE BAY AND THE CO-OPERATION OF MARYLAND AND VIRGINIA FOR THEIR CONSERVATION

By Jno. S. Parsons, *Commissioner of Fisheries of Virginia, Accomac, Va.*

The Chesapeake Bay is by far the largest bay in the United States. It lies entirely within the boundaries of Maryland and Virginia, and has a length of nearly two hundred miles. In Maryland, its width is from five to ten miles; while in Virginia, it is from fifteen to thirty miles wide. Its shore line is everywhere very irregular, being indented by many bays and sounds besides the numerous rivers which empty into it. Nowhere else in the United States, and, in fact, nowhere else in the world, I am informed, are the mouths of the rivers so near together as are those emptying into this bay. On its west side, from Point Lookout to and including Hampton Roads, a distance of sixty-five miles, there empty into this bay and its tributary bays, the Potomac, Great Wicomico, Rappahannock, Piankitank, North, East, Ware, Severn, York, Posquosin, Back, James, Nansemond and Elizabeth Rivers; fourteen rivers in a distance of sixty five miles. The Potomac is eleven miles wide at its mouth. The Rappahnanock and the James are each about four miles wide. The other rivers are narrower; but the aggregate width of the mouths of these rivers is more than half the entire distance of this sixty-five miles.

While the Chesapeake Bay, as already stated, is entirely within the boundaries of Maryland and Virginia, its tributaries spread out fan-like north, east and west and drain not only Maryland and Virginia, but much of West Virginia, Pennsylvania, New York and Delaware, an area of more than forty million acres. From the hills and valleys of this great territory these rivers bring dis-

solved minerals and organic matter to this bay, where such matter makes a long halt in its journey to the ocean, and is deposited all over the bay in the form of a fine, light, black sediment. This sediment is extremely rich in organic matter, and in the shallow waters of the bay produces a luxuriant vegetation, most of which is not visible to the naked eye. This microscopic vegetation, furnishes food for countless minute animals, and these animals in turn furnish food for larger animals. In this way the washings brought to the bay by these rivers are turned into food for man in the form of delicious oysters, clams, crabs, scallops, terrapin and fin fish of countless varieties; and thus are nourished the fisheries of this bay.

The importance of these fisheries is not generally realized and the extent to which it is possible to develop them, especially the shell fisheries, is dreamed of but by few. At the present time more than one hundred thousand persons in Maryland and Virginia secure their entire support from these fisheries, and the incomes of several times that number of people are materially increased because of the millions of dollars brought into these states annually in exchange for these fisheries products, which are now sent to every part of the country.

This bay undoubtedly produces fin fish in quantity, quality and variety unsurpassed anywhere by an area of equal size; and as a natural oyster-producing territory it leads the world.

Professor James L. Kellog, professor of Biology in Williams College, in writing of the Chesapeake Bay oyster, said: "Every one is familiar with the frequently repeated statement that the Chesapeake Bay is the most extensive and prolific oyster territory in the world. This statement is undoubtedly true. When one compares it with the northern field, the marvel of its natural fertility it astonishing." "If extensive and scientific oyster culture were employed here, as it is in Long Island Sound, the result would astonish the world." He also said: "When all opposition to oyster culture has vanished, the

Chesapeake, rich with food for an unlimited oyster growth, free from the most destructive of oyster enemies, with its safe and unvarying natural conditions, will prove to be of greater value to the people on its shore than mountains full of silver and gold."

The late Professor Brooks of Johns Hopkins University, in writing of the Chesapeake Bay, said: "The opportunity for rearing oysters there is unparalleled in any other part of the world." He, however, severely criticized the short-sighted policy under which both Maryland and Virginia were at that time (1890) permitting this industry to be handled. He said: "The total harvest of oysters from the Chesapeake Bay since the establishment of packing houses is fully four hundred million bushels.

"This inconceivably vast amount of delicate and nutritious food has been yielded by our waters without any aid from man. It is a harvest that no man has sown; a gift from bounteous nature.

"The fact that our waters have withstood this enormous draft upon them, and have continued to meet our ever increasing demands, is most conclusive evidence of their fertility and value; and the citizens of Maryland and Virginia might well point with pride to the boundless resources of our magnificent bay were it not for two things.

"The first of these is the fact, which for many years we strove to hide even from ourselves, that our indifference and lack of foresight and our blind trust in our natural advantages, have brought this great inheritance to the verge of ruin. Unfortunately, this is now so clear that it can no longer be hidden from sight nor explained away, and everyone knows that, proud as our citizens once were of our birthright in our oyster beds, we will be unable to give to our children any remnant of our patrimony unless the whole oyster industry is reformed without delay.

"We have wasted our inheritance by improvidence and mismanagement and blind confidence; but even if our beds had held their own and were today as valuable as

they were fifty years ago, this would be no just ground for satisfaction in this age of progress, to a generation which has seen all other resources developed and improved."

This criticism was undoubtedly deserved, and caused efforts to be made by both states looking to the restoration and conservation of this great industry. Laws were enacted establishing closed seasons; requiring the culling of the oysters on the beds and the returning of the small oysters and shells to the bottons to form a nucleus for another crop; and prohibiting the taking of oysters at all by injurious and destructive methods.

These laws were at first very unpopular and were very difficult to enforce. Gradually, however, their beneficial effects became apparent even to the oysterman; and now these laws are enforced to the letter with little difficulty; and the oystermen as a body would be the first to oppose their repeal.

So generously does nature respond to proper treatment that our natural beds, with few exceptions, are now restocked with as an abundant supply as formerly; and, too, the prejudice against leasing the barren bottoms for oyster culture is fast passing away. Especially is this true in Virginia, where vast areas are now under cultivation, producing millions of bushels annually. The oyster planting industry, however, is still in its infancy with us, and has been confined entirely to the shallow waters of our rivers and small bays; and not until this year has deep water planting in the bold waters of the Chesapeake Bay been demonstrated to be a success. Thousands of acres of this deep water territory are now being leased, and the methods of deep water planting, which have proved so successful in Long Island Sound are now to be applied to the Chesapeake Bay. And, too, the Virginia law prohibiting the investment of non-resident capital has been repealed so as to permit sufficient capital to be secured to develop this great industry.

I feel that the prophecy made by Professor Brooks in 1890 is soon to be realized, certainly as to the Virginia

part of the bay. He said, "It will take many years of labor to bring the whole bay under thorough cultivation, and great sums of money; but the expense and labor will be much less than an equal area of land above water requires. While it may be far away, the time will surely come when the oyster harvest each year will be fully equal to the total harvest of the last fifty years, and it will be obtained without depleting and exhausing the beds, and without exposing the laborers to hardships or unusual risks."

The fulfillment of this prophecy will be materially hastened by a continuance of the present efforts of Maryland and Virginia for the protection and development of the industry of the entire bay.

Until recently the states of Maryland and Virginia worked independently of each other. There was practically no co-operation in the enforcement of the laws, and but little effort to get together for the enactment of similar laws looking to the conservation not only of the oyster industry, but to the conservation of the fin fish of the Chesapeake Bay. It is apparent that such co-operation is much more necessary for the conservation of fin fish than for shell fish. One state might possess a highly developed and increasing oyster industry while the industry of the other state might be going rapidly to destruction.

Co-operation, however, between the two states in regard to the oyster industry is producing splendid results in enforcing the laws of the two states; and still greater benefits are expected from the co-operation as to the fin fish. We expect to accomplish the same results as to certain of our migatory fish as might be attained by federal control.

Such co-operation as to the fin fish, which pass freely from the waters of one state to the waters of the other, is absolutely necessary for their protection. Each state suffers from the neglect and lack of protection of the other, and indeed, it is only possible to conserve the fin fish of the Chesapeake Bay by the co-operative efforts of both Maryland and Virginia. All thinking people of both

states have at last been forced to realize this truth, because of the gradual decline of many varieties of our fish, especially the shad, herring and crab. Until very recently practically no protection was given in either state to these fish, and the result is what might have been expected. Both states permitted the taking of them at all times and in practically any manner.

No species of fish was at one time more important to the entire Atlantic Seaboard than the shad, and none whose preservation so immediately concerns a larger number of persons. When we consider the fact that the waters of the Chesapeake Bay and its tributaries formerly teemed with this most valuable fish, and furnished at least forty per cent of the output of the entire Atlantic Coast, we realize how important it is that Maryland and Virginia should use every effort not only to conserve our present supply, but, if possible, to cause our waters to become replenished with as an abundant supply as formerly.

A little study of the habits of these fish while in the Chesapeake Bay will convince anyone how necessary it is for the two states to co-operate in protecting them. They enter our waters annually solely for the purpose of spawning, making their appearance in the lower Chesapeake Bay about the first of April and proceed up the bay and up the rivers to their spawning grounds. Their spawning period is over about the middle of June, when they disappear from our waters and are seen no more until the following Spring.

It is evident that if the supply of this fish is to be maintained, practically the same number should reach the spawning grounds each year, and the spawning grounds should not be interfered with by destructive methods of fishing. The present scarcity of this fish is attributed not so much to the numbers caught each year by the fishermen as to the annually decreasing numbers that succeed in reaching the spawning grounds, and to the use of haul seines on the spawning grounds.

Perhaps none of the agencies which operate to prevent the shad from ascending the rivers as freely as formerly, can be entirely remedied, but present conditions can be greatly improved.

Some of the agencies which with us are preventing shad from reaching their former spawning grounds, are the following:

1. Dams have been constructed across some streams, completely blocking the passage to the spawning grounds above and effective fish ladders have not yet been provided.

2. The sewerage from certain cities has not only so polluted the nearby waters as to prevent some of these fish from going through it to the spawning grounds above, but it destroys much of their spawn. Much spawn is also destroyed by washings from cultivated fields, waste from manufacturing plants and by the sawdust dumped into the rivers from saw mills.

3. Extensive pound net fisheries near the mouths of certain rivers, and stake nets in the rivers, have acted in the nature of dams and have doubtless been more effective in preventing the shad from reaching their spawning grounds than all other agencies combined.

Little effort was made by either Maryland or Virginia until recently to regulate the setting of these nets, and they were set in the bay and in the rivers in such a manner, and in such numbers as to almost block the entrance to the rivers and the rivers themselves. They were extended into the channels to such distances as to seriously interfere with navigation, and it became necessary for the War Department to establish lines in the bay and rivers beyond which no net could be set. This action has been very beneficial in keeping open the deeper channels and thus affording an unobstructed continuous passage from the deep waters of the bay to the spawning grounds in the rivers. These passages are, however, very narrow in places and further relief of this kind is needed.

Virginia is the more serious offender in respect to these nets, but Maryland contributed her part to the de-

struction of the shad by permitting the use of haul seines on the spawning grounds. These seines not only catch the ripe fish which are about to spawn, but what is far more serious, they haul ashore vast quantities of eggs, which have been deposited on the bottoms by the spawning fish. The injury done by a single sweep of one of these seines, at times, is indeed alarming. Fishing on these spawning grounds should be confined to drift nets and in some localities small stake nets might be permitted.

All attempts to secure legislation in Virginia regulating and restricting the use of pound nets has been opposed by the fishermen with the argument that such restriction would merely permit the fish to go into Maryand waters to be there caught by the haul seines on the spawning grounds.

I understand that the efforts to prohibit the use of haul seines on the spawning grounds in Maryland waters have been opposed with the argument that such legislation would benefit only the Virginia fishermen as practically all of the fish hatched in the Maryland waters would be caught on their return to the bay by the Virginia Fishermen before they ever reached Maryland waters. It seems that the fishermen of both states realized the harm they were doing and justified their acts on the ground that as the fish were being destroyed they might as well get what they could while they were going.

It is evident that what it needed is for both Maryland and Virginia to pass laws regulating the setting of pound nets so as to provide broad and continuous passages from the deep water of the bay to and up the rivers to the spawning grounds, and to prohibit the use of haul seines on the spawning grounds. Virginia has passed such a law which will be in operation next season. In order to secure its passage, however, it was necessary to assure the legislature that Maryland officials had promised to use every effort to have such a law enacted at the next session of their legislature.

When these laws are in operation in both states, it will only be necessary for the two states to go a step further and supplement the splendid work being done by the National Government in artificially hatching shad fry. If both Maryland and Virginia will do what has already been agreed upon, I feel confident the shad fisheries of the Chesapeake Bay can be restored to their former proportions, although it will take some time to do it.

The co-operative efforts of Maryland and Virginia for the protection of the crab is already showing good results.

Carrying out an agreement of the Fishery Officials of the two states, laws were enacted by the last legislatures of Maryland and Virginia, protecting the spawning crab and preventing the taking of hard crabs measuring less than five inches from tip to tip of spike. This law is about equally burdensome upon the fishermen of both states, but in a different manner. Practically no crabs spawn in Maryland waters, while during June, July and August, more than ninety per cent of all crabs found near the Virginia Capes are spawning crabs. This law resulted this season in closing the Virginia crab packing houses during July and August, as sufficient other crabs could not be obtained during that time to justify their working.

The crab cull law, however, does not affect the Virginia crabbers, as practically all the crabs in the Virginia waters are mature crabs. The young and growing crabs stay in the upper waters of the bay — in the Maryland waters—and the small crabs which have to be returned to the waters by the Maryland crabbers constitute a large per cent of their total catch, especially in the spring and early summer. Before this season, these small crabs were saved and sold to the dealers, four or five being counted as one.

At first the crabbers were very much opposed to this law but they are now pleased with it, and admit that it is responsible for the plentiful supply of mature crabs this fall. The small crabs which were returned to the waters

this spring and summer have matured and are now being caught and saved. It will, of course, take longer for the beneficial effect of protecting the spawning crab to be seen, but no one doubts now that the crabbing industry of the Chesapeake will in less than five years, be double what it is at present. Crabbers are unanimous in saying that they have been more successful this fall than for many years.

Space will not permit the further discussion in detail of the benefits Maryland and Virginia expect from co-operative efforts, but I will say that the officials of both states realize it is the only way to successfully handle the situation, and are determined to co-operate in every possible way for the conservation and development of the great natural resources of their magnificent bay, to consider the industries as a whole, and not to allow small local interests or prejudices to influence them in their actions.

A joint conference of the Conservation Commission of Maryland and the Commission of Fisheries of Virginia, was held in July of this year on the Potomac River, Governor Harrington of Maryland, Governor Stuart of Virginia, and Dr. Moore of the Bureau of Fisheries participated. So beneficial was the exchange of ideas on this occasion, so important were the agreements entered into, and so great was the interest created in the fishery industries, that it was unanimously decided to make the conference an annual event. We expect upon these occasions to discuss and agree upon the legislation needed in each state, to draft as nearly uniform bills as conditions permit, to have the same introduced in our respective legislatures, and we have agreed to use every effort to secure the passage of such bills as we agree upon.

The executive officers of the commissions of both states have agreed to meet frequently to discuss the enforcement of the laws, and the general conditions of the industries. Such a meeting will be held next week on the Potomac River to arrange for co-operative work in enforcing the oyster laws there.

As a result of this spirit of co-operation, I am encouraged to believe that a much brighter day is dawning for our fisheries, and that it will not be long before many of our declining industries will be restored to their former greatness; that others will be developed and increased to undreamed of proportions, and that the Chesapeake Bay will indeed be more valuable to the people of Maryland and Virginia than mountains full of gold and silver.

FEDERAL CONTROL OF INTERSTATE WATERS

BY EBEN W. COBB, *State Superintendent of Fisheries, St. Paul, Minn.*

Though federal control of all interstate waters would doubtless be a good thing, what I have to say is largely brought to mind by my work in connection with the Mississippi River.

Of course, we are all aware that there is a wide difference of opinion as to where the authority of the United States Government leaves off and that of the various states begins, in this as in other matters, but I am assuming that each has authority where they are now in control.

Each state along a stream or body of water which separates two or more states, makes laws regulating the fishing according to its own ideas, and in some instances with the idea in view of securing an advantage over the other states interested. This leads to reprisals and the waters suffer to a greater or less extent.

In that portion of the Mississippi forming the boundary of Minnesota, we have not suffered much from this source as our sister state on the east has been very friendly with us and we might almost say that a partnership exists between the two states for the purpose of enforcing the laws along the boundary line.

The greatest difficulty comes up in regard to the maintaining of the river as a source of supply for game and commercial fishes.

The Mississippi River, with its hundreds of miles of shore bordering on many different states and supporting in its waters many varieties of both food and game fishes, should be made to produce an enormous amount of fish without in any way reducing the amount left in the river. No one state could probably be brought to support a hatchery for the purpose of stocking waters such as these

where the benefits derived would be shared by other states. The states are in most cases chiefly concerned in propagating game fishes and the better class of food fishes, such as the lake trout and pike-perch, which rank as game fishes in some states, and could hardly be brought to undertake any such task as adding to their work the propagation of food fishes for the river.

This is a large undertaking and could only be carried out by the Federal Government as it would require a plan covering many states and a knowledge of the many varieties of fishes which can only be secured through institutions such as the biological station now operated at Fairport, Iowa.

Several years ago, it was found that many fish were landlocked in the sloughs along the river and it was undertaken to rescue them. These fish added considerably to the number available for distribution and the work became quite popular. The rough fish were returned to the river along with a part of the game fish and the balance sent to applicants in various parts of the states securing them, or to states farther away by the Federal Government.

As the demand for game fishes is always great, it becomes easy to send away more and more of them, leaving only the rough fish for the river, and it also becomes easy to take those which are nearest at hand. This leads readily to taking them from spring-fed sloughs, cross channels and the mouths of streams, and the work becomes in effect an effort to secure a supply of fish to fill applications rather than an effort to rescue fish which are in danger from the freezing or drying up of the sloughs.

You will bear in mind that I am not making any statement about any state or federal work with a view to discredit any one, but am simply stating my own ideas in this matter. When appointed Superintendent of Fisheries of Minnesota, I entered into this work thinking it to be of great importance. Many fish had been rescued and many applications filled with these fish which would presumably have been lost if left alone. A crew of men were

hired and paid by the day or month to carry on the work, but, in spite of the fact that the men worked hard and fished all sloughs that it seemed desirable to fish, the number secured did not come up to expectations. Where fishermen had made good money seining and delivering bass and crappies at three to three and one half dollars per thousand, they cost us in many cases as high as ten dollars per thousand. The fishermen told me at that time that they would gladly go back to the old method and seine by the thousand if I would only keep away from them entirely and promised that there would be a large number of bass secured. This convinced me that to get large numbers of these fishes it was necessary to take them wherever you could. This would be somewhat to our advantage as these fish could be planted in inland waters while if left in the river they would be likely to go to waters belonging to other states.

Of course, the rough fish returned to the river, have a great value and no one would argue that this work should be stopped, but the tendency is to make it as easy as possible to secure that which shows most and make a good record rather than consider the greatest good to the waters. I do not believe the various states could be brought to attempt the carrying out of a comprehensive plan for bettering the interstate waters and so consider it a work for the Federal Government. All the work connected with these waters could come under federal control and hatcheries could be maintained to increase the supply of fish of all desirable varieties, both for the sportsman and the commercial fisherman.

The Great Lakes, the rivers of the Pacific and Atlantic Coasts and the inland lakes and streams throughout the country are provided with fish artificially hatched while this great stream is used as a source of supply to furnish fish for other streams, while receiving few in return except those taken from the sloughs and returned to the river from whence they came. Would it not be to the advantage of all to build up the fisheries of this great waterway rather than to injure it by the continual taking away

of the fishes secured through our rescue work? And who is better able to undertake this work than the Federal Government with its facilities for learning the habits and needs of the numerous fishes found here?

Would it not be possible to so arrange matters that this whole water system would be placed under the authority of the Federal Government and the various states would cease to exercise control? The government is taking charge of the birds that fly from one state to another. Why should it not take charge of the fishes that swim freely from one state to another?

This is brought up not to inform those here of anything which they did not know before but to direct attention again to this matter which is becoming of real interest to those living along the valley of the Mississippi.

THE CONSTRUCTION OF A POND CULTURAL STATION, AND THE PROPAGATION AND DISTRIBUTION OF LARGE MOUTH BLACK BASS IN SOUTH CAROLINA

By G. W. N. Brown, *Superintendent, U. S. Fisheries Station, Orangeburg, South Carolina.*

The factors which exert the greatest influence on the success of artificial propagation of black bass are: the proper construction of ponds, the complete control of the water system, and an adequate supply of natural food.

With these objects in view, especially the last named, a site known as Dukes' Fishery, about two miles south of Orangeburg, South Carolina, was selected for the establishment of a federal fish hatchery, although to a casual observer it would have seemed a most unlikely place for the construction of ponds for proper manipulation as a pond cultural station.

Dukes' Fishery consisted of three ponds, built several years ago, the lower containing six and three-tenths acres, the others, five and seven-tenths and four and two-tenths acres respectively. They were located in a spring-fed marsh, consisting of loose mud, sediment, and decayed vegetation, containing also a large number of stumps, old logs, and other debris, a large percentage of which was buried beneath the mud. Plans were made for developing the lower of these old ponds into six brood ponds, ranging in size from six-tenths to one and five-tenths acres, and six cement retaining ponds sixty feet long, eight feet wide and three feet deep. In the construction of the brood ponds the features kept constantly in view were: easy manipulation; ideal breeding grounds for the animalculae; the prevention, as far as possible, of cannibalism; the perfect control of the water system, and as near approach to natural conditions for the spawning

fish as is possible in pond culture. These features are, for the most part, closely allied, inasmuch as the proper grading of the pond bottoms and the consequent varying depths of water enter largely into proper control of conditions that tend to successful pond culture.

Since from the marshy, uneven character of the natural bottom it would be impossible to seine or draw and clean the ponds, it became necessary to remove the stumps, logs, decayed vegetation and loose mud, and substitute foreign material to make bottoms sufficiently compact to support the weight of an attendant while working in the ponds. Accordingly, more than two thousand stumps were blown out with dynamite and removed from the site by means of a log skidder. The mud and debris was removed to a sufficient depth and a layer of coarse sand from a nearby hill was spread over the bottoms from one to three feet in depth. This made an excellent bottom, even beyond the most sanguine expectations. The outlet box was located near one corner of each pond and the bottom so graded as to afford varying depths of water from about six inches at the opposite corner to about five feet at the outlet. This method of constructing pond bottoms enables the parent fish to select any desired depth of water for nest building. It also affords an early spring growth of aquatic vegetation and stimulates early breeding of animalculae by supplying warmer water and more suitable breeding grounds in the shallower waters of the pond than are to be found in the deeper parts. Thus when the fry are ready to take food, they find an abundant supply ready for their consumption, in a locality where there is a minimum danger of their becoming prey of the adult fish, as they, being more agile, may elude their pursuers in the thick vegetation. This method of constructing ponds is also advantageous in drawing them for collecting the residue of fingerlings, or for transferring the adults and cleaning the ponds, as there is always sufficient depth of water near the edge to support the fish and the inclination of the bottom

tends to keep the stragglers up with the procession, and to assist those in returning that became stranded.

Indisputable evidence that this method of construction is adapted to the propagation of black bass, and that the fingerlings avail themselves of its advantages, is the fact that the 100,000 No. 1 fingerling bass were collected from the ponds for distribution by means of casting seines of ten and twenty feet lengths from the water's edge before it became necessary to enter the water and haul the seines, and the fact that young bass taken from the ponds on July 3 measured six inches and others taken on September 20 measured nine inches and weighed one-half pound.

Experience and observation have demonstrated the fact that it is impossible to do successful pond cultural work without an adequate supply of natural food, also that the only reliable source of this supply is the breeding of animalculae on aquatic vegetation. No nearer approach to natural conditions is possible in pond culture than by providing the fish with any desired depth of water, a sufficient supply of natural food, and facilities for escaping their enemies.

Perfect control of the water system on the Orangeburg station is secured by means of cast iron pipe lines laid from the reservoir to the various ponds and provided with brass trimmed valves, with cement boxes, screened, at both intake and outlet ends. From the overflow box of the reservoir a twenty-four inch terra cotta main drain extends alongside the pond system to the extreme lower end. When rains come and the reservoir becomes muddy, the valves supplying the ponds are closed and the muddy water diverted through this drain. All ponds are provided with cement outlets and suitable terra cotta drains connecting with the main drain.

The brood ponds were completed and the collection of brood bass was begun in December, 1915. By the time the fish were ready to spawn, 300 had been collected and placed in the ponds. Nest building began the last days of February. The first eggs were found March 14 and

the last seen on July 1. By April 20, there were several schools of No. 1 fingerlings ready for distribution. The first messenger trip was made April 25. Between that date and May 20 inclusive, 135,000 No. 1 fingerlings were sent to applicants.

The following method is employed at the Orangeburg station for collecting the fingerlings from the ponds, counting and putting them in cans for shipping. Two wooden troughs fourteen feet long, fourteen inches wide and eight inches deep, are set up in one of the cement retaining ponds, and divided into separate compartments by screens. On the day prior to shipment, the fingerlings are taken from the ponds with bobinet seines ten or twenty feet long and six feet wide. A small chain instead of leads, is attached to the bottom of the seine in order to press down the vegetation and keep the seine as nearly as possible in contact with the ground. Every resonable precaution is taken to prevent loss through careless handling. A galvanized iron tub with a perforated overflow near the top is used to convey the fish to the troughs. To accustom them gradually to the temperature of the water in the trough, the tub when brought from the pond is placed under the overflow of one of the troughs in such a manner that the water in falling is divided by the edge of the tub and only the desired amount allowed to enter. The fingerlings are then put into one compartment of the trough, from which they are counted into another by means of bobinet hand nets. These nets are constructed very shallow so as to prevent the fingerlings from grouping in the center and rendering the counting difficult. About five to ten are taken up at each dip of the net, and being well distributed over the nearly flat surface are rapidly and easily counted. When a sufficient number have been collected and counted for next day's shipment the troughs are covered with cheese cloth screens and left over night.

As the economic value of the fish cultural station consists in the number and condition of the fish actually delivered to applicants, it is important that the cans be not

over crowded. It has been found at this station that not more than 500 No. 1, or 200 No. 2 fingerlings per can, can be carried with safety. The total number desired for the shipment having been counted by the foregoing method, they are apportioned to the cans, when being loaded, by as accurate estimate as is consistent with rapid handling. On one occasion, when the fish were being put up before daylight for shipment, two lots were put into one can accidentally, leaving one can without fish. This was not discovered until about one hour later, when the messenger in charge noticed the fish in the overloaded can were dying, and upon investigation discovered the trouble. When he had removed about half the number into the can which had contained no fish they ceased dying.

Since the beginning of the season, 152,600 No. 1 to No. 5 fingerlings have been distributed to applicants with a loss of less than 1,000. The ponds are now being drawn for collecting the residue, and it is possible that the output may be increased by 15,000 to 25,000.

One feature that has contributed materially to the success of the work at Orangeburg is the perfect harmony existing between the fish culturist and the superintendent—the singleness of purpose to render honest, efficient service. There can be no real success where discord and confusion exist.

A MICHIGAN FISH SURVEY

By T. L. Hankinson, *Charleston, Ill.*

A study of the fauna of Michigan is being made by the Michigan Geological and Biological Survey, by employing field naturalists who gather data on the part of the fauna that they are especially interested in and best qualified to study. Specimens are collected and notes are taken. After these have been worked over by the investigators, the important facts are published by the Survey in the form of papers in its bulletins and other publications. The specimens are kept as a part of the Survey's growing collection illustrative of the fauna of the state. The biological studies are carried on under the direction of Dr. A. G. Ruthven, Chief Naturalist of the Michigan Geological and Biological Survey.

The writer has been employed by this Survey to make studies of the fish of Michigan, with a view to finding out what species of fish are found there and as much as possible about each species; its distribution, the relative abundance of its individuals, its habitats, habits, and economic importance.

About eight weeks of field work has been done on this general study of Michigan fish by the writer since the work was begun, in the spring of 1915. Much time has been spent in studying the fish collected and in examining literature. The results of all this work are to be published as a monograph of the Fishes of Michigan. This can not be very pretentious on account of limitations as to time and funds, but it is hoped it will be sufficiently complete and comprehensive to serve as a field manual for those who wish to study the fish of the state. In this way, the publication may develop interest in fish in the state and increase the number of collectors and observers of fish life, so that in time a larger and more elaborate treatment on the fish of Michigan can be pro-

duced—one comparable with the very valuable work on the Fishes of Illinois.

Few states have a fish fauna so interesting and extensive and of such economic value as that of Michigan, and which is so deserving of scientific consideration. Already much work of this kind has been done in the state and its adjoining Great Lake waters, chiefly by the University of Michigan, the Michigan Fish Commission, the State Geological and Biological Survey, and the U. S. Bureau of Fisheries, but the published results of fish work in the state are considerably scattered, and much valuable material is in publications not readily available. The paper by Ellis L. Michael (1904), entitled "Catalogue of Michigan Fish,"* represents the only productive effort to compile data on Michigan fish with which the writer is familiar. Mr. Michael very successfully and carefully gathered and sifted the data on the occurrence and distribution of the species of fish in Michigan, but since the time of appearance of this paper, many data have been obtained and published, based chiefly on work by the University of Michigan expeditions, work at the Biological Station at Douglas Lake, and work by the Michigan Fish Commission. It is undoubtedly time for an inventory of facts relating to Michigan fish, but before a publication on the fish of the state is written, more field work should be done and this in some of the many parts of the state having fish life that have not been scientifically examined. The writer has been looking up these places and confining his field work almost entirely to them. The smaller forms are given more attention than the larger ones for the latter are mostly food and game fish and are pretty well known.

Some fifty localities in Michigan have been visited by the author since May, 1915, when this general survey of the fish of the state began. These localities are in sixteen counties and include nineteen stream systems, nine inland lakes, three lakes connected with Great Lakes, and the shallow water along shore of Lake St. Clair, St. Clair

*Sixteenth Report of the State Board of Fish Commissioners.

River, Lake Huron, Makinac Straits, Lake Superior, and Lake Michigan and also the deep waters of Lake Huron, Lake Superior, and Lake Michigan. Limitations in time and funds for this Survey have not permitted very thorough collections to be made at any one of the places, but in nearly every case, enough specimens were taken and enough observations made to give a good idea of the general character of the fish fauna of the place; and the collections contain most of the smaller species together with young of many of the larger ones. At every place where fish are taken, notes are made on the following: locality, date, time of day, area fished, character of water, bottom, depths, currents, aquatic and littoral vegetation, invertebrates, vertebrates other than fish, fish seen and not taken, fish taken, sky, wind, precipitation, air temperature, and water temperature. Photographs were made to show the vegetal and other features of the most favorable fish habitats. In all cases efforts were made to get information from fishermen and others familiar with the fish of the region. Such was in all cases freely given, and it was gratifying to find how willing people were to co-operate and to see the good interest that they took in the scientific work. Commercial fishermen were especially obliging and allowed me to accompany them in their boats to their nets and to take what I wanted from their hauls for specimens. They are desirous of more knowledge of the creatures by which they make their living and welcome the results of scientific work. Some very material help and much encouragement were obtained from persons met, who were connected with the State Fish Commission or with the State Game, Fish and Forestry Department.

An important source of material and notes has been the efforts of certain teachers and other reliable persons, capable of collecting small fish and furnishing accurate notes with them. Whenever such persons are found, who are willing to assist in the work, directions are sent them for getting, preparing and shipping material. After receiving this, the writer studies it and returns

to the collectors named sets of duplicates of the different species.

All of the collections made in this survey are to be kept at the author's laboratory at Charleston, Illinois, till after the report on the work is finished, when they will be sent to the Museum of Zoology at Ann Arbor, Michigan, where the collections belonging to the Michigan Geological and Biological Survey are kept.

Little can be given in the way of results in this paper for not half of the collections have yet been looked over, and more field work is still to be done, and much more literature is yet to be examined. It seems very likely that important contributions to our knowledge of the ecology of Michigan fish will come from the investigations, and probably we will know considerably more about their distribution, habits and life-histories. The work should give results of value to fish culturists and others interested in conserving fish life, for most of the facts obtained should be of economic value, although many of them will not be immediately applicable in furthering the welfare of Man.

THE ULTIZATION AND PRESERVATION OF FRESH-WATER MUSSELS

By Robert E. Coker, *Washington, D. C.*

The fresh-water mussels, or, in the language of the river banks, the "clams" that grow half-buried in the bottoms of our streams, form a state and national resource that is too little appreciated. Their importance is based only in part upon the facts that they are a basis of fishery for shells amounting to some eight hundred thousand dollars a year and of pearls amounting to about four hundred thousand dollars more, and that they furnish a livelihood to ten thousand fishermen and their families, while they support an industry yielding an annual product, principally of buttons, valued at from five to nine million dollars, according to the state of the trade, and employing several thousand wage earners. The real value of the mussels is intensified by the fact that they are the principal source of material for the manufacture of a universal necessity, as well as the best abundant material for this purpose. We can enumerate statistically, as we have in part, some of the concrete benefits derived from the capture and utilization of mussels, but if your memory can return over a period of 25 years past, you will understand that we can go further and say that without the fresh-water mussels, each and every person in this country, practically speaking, would be deprived of the opportunity to obtain a most ordinary, commonplace necessity at anything like the present modest prices for an article of good quality. Leaving out of account then, the producer, the manufacturer, and the unhappy middleman, let us consider the interest of the consumer as paramount. Now in the case of the fresh-water mussel and its trade product, the fresh-water pearl-button, the consumer is almost every human being within the confines of the United States and many without. It is easy, therefore, to apply the *argumentum ad hominem.* Exclude

or wipe out the fresh-water pearl material, and you will have the choice of two or three alternatives. You will pay several times the price for an article of equal quality; you will return to the use of very inferior materials at probably greater cost; or you will adopt a practice that prevails, we are told, in some remote regions of the earth where the buttons are handed down from generation to generation. Let us recognize that our river mussels mean something to a considerable number of fishermen, to manufacturers and to wage earners, and furthermore that they mean something to every citizen of every state in the Union. We must be surprised then to find in every state concerned so little general interest in these public assets, so little feeling of custodianship for a genuinely valuable resource. There exists, not so much a feeling of indifference to the future of the mussel fishery, as an actual condition of misconception of the relative and enduring importance of the mussel beds. It will be the purpose of these remarks to attempt to remove some of the possible misconceptions and to solicit from all those who may have opportunity or influence a more active effort for the adoption of a proper policy in the several states looking to the preservation of the mussel resources while permitting and ensuring the existence of a judicious fishery.

I. Has the mussel industry a permanent character?

The pearly mussels enter into commerce in a variety of forms, but the principle product is the button. The most recent figures show that about nineteen and one-half millions of dollars worth of buttons of all kinds are manufactured each year in the United States. These are made from a great variety of materials, such as agate, bone, celluloid, glass, horn, metal, fresh-water and ocean pearl, vegetable ivory, etc. Of all the materials, however, the American fresh-water pearl was by far the most important. The only button which anywhere nearly approached the fresh-water button in quantity produced was the shoe button (of all kinds), and it needs no ex-

tended argument to show that the shoe button cannot take the place of the pearl button. The only class of button which anywhere nearly approached the fresh-water pearl button in value of output was the vegetable ivory button, which is quite too expensive for the most common uses. Now the imports of buttons are nearly negligible. It follows that the staple button of domestic commerce is the fresh-water pearl, and the principal source of material for buttons is the mussel of our rivers.

To quote from an official statement of the Bureau of Foreign and Domestic Commerce*—"the manufacture of pearl buttons, chiefly fresh-water pearl, was the most important branch of the [domestic] button industry, representing 43.2 per cent. of the total quantity and 45.4 per cent. of the total value of the output. Next in importance was the manufacture of buttons from vegetable ivory, the output of these amounting to 8.5 per cent. of the quantity and 17.8 per cent. of the value of the total button product." That the fresh-water mussel is the paramount material for button manufacture is, I am sure, not generally recognized. In the face of a knowledge of such facts, it is impossible to imagine that the fresh-water pearl button industry, peculiarly American as it is, can be anything but stable and enduring.

Furthermore, let us ask what material we would substitute for the fresh-water pearl. Notwithstanding that the pearl button is the best in quality for its purposes, it is one of the very cheapest of all. Only bone buttons, shoe buttons and the lower grades of metal buttons, can be purchased for less money. Now we have tried bone buttons and cheap half-metal buttons, and we know the tribulation thereof, and we do not wish to try the shoe button, except in its proper place.

The answer to our question as to the permanent nature of the fresh-water mussel industry is now obvious. It may be assumed that as long as we continue to wear clothing

*Special Consular Reports No. 75. Foreign Trade in Buttons. Chapter I. American Button Trade. Department of Commerce, Washington, 1916.

fastened with buttons, there will be a strong demand for domestic shells. Consequently, it is our responsibility, not only to prevent the extermination of mussels, but to effect an abundant and widespread growth of them, so that they may continue to furnish a product possessing the unusual combination of excellent quality and low cost. For an industry to endure there must be not only demand for the product but also a supply of materials. We are brought then to our second question.

II. Is the supply of fresh-water mussels enduring?

The mussels, needless to say, are living animals which naturally grow and reproduce. Such resources are not inevitably exhaustible like deposits of past ages which are, practically speaking, fixed in amount and not subject to growth or increment. They may, however, be exhaustible like certain sorts of forest growth if the rate of reproduction cannot keep pace with the consumption involved in any practical form of utilization. The mussel industry does not exist by virtue of a "draft upon the accumulation of mussels of past years." Such an impression has been known to exist, but it is not held by any who are conversant with the history of the mussel fishery.

In the early times of the shell fishery—and that was less than 25 years ago— the beds were exhausted with great rapidity, and principally for two reasons. Few mussel beds were then known and these were intensively and one might almost say frenziedly worked; so that in restricted localities a more intensive fishery marked the stage of infancy than is known now that the industry as a whole has developed to vastly larger proportions. Furthermore, it was at first supposed that the shells of only one or two species of mussels were adapted for commercial use; consequently great quantities of the best shells were gathered only to be thrown away, and shelling was pursued with excessive waste. Under the pressure of necessity, however, more and more of the variety of mussel species came into use, and the shelling industry spread from stream to stream and from state to state until it

now extends from the Dakotas to Tennessee, and from Minnesota to Louisiana.

In the course of this brief development of the fishery, two significant observations have been made. One is that an exhausted bed will recuperate, given a sufficient period of rest, if the bed has not been too thoroughly depleted. The other is that the quality of shells yielded by a mussel bed is often distinctly improved after the first years of working. Certain streams in Arkansas, for example, are said to have first produced a rather undesirable shell, old, thick and coarse; but after a little time a smaller shell of prime quality came to predominate in the catches, and these were unexcelled by those from any part of the country.

Formerly it was supposed that the commercial shells were of excessively slow growth, requiring 12 years or more to reach maturity. We now know that there are slowly growing species and fast growing species. Some may indeed require 8 or 10 years to reach a proper size, but others of equal commercial importance attain a marketable size in four or five years.

Our mussel resources are potentially self-perpetuating, given a reasonable opportunity and practicable assistance. The mussel industry is not dependent for temporary prosperity upon the eradication of its material basis. It is perfectly feasible to have an important mussel fishery enduring as long as the demand for mussels continues, and that demand, as we have seen, is, humanly speaking, a permanent one.

It does not follow that the shell resources cannot be exhausted either locally or as a whole. Since the mussels are living forms dependent for reproduction upon the maintenance of a stock sufficient for casting the seed of successive generations, it is obvious that they cannot withstand an entirely heedless onslaught. The perpetuation of the resources is consistent with their utilization, but it is quite dependent upon the adoption of a rational policy of conservation.

III. Is there a tendency toward depletion?

An obvious answer to this question is found in the continual extension of the territory of fishery. The shelling industry has been geographically conservative, seeking new locations principally because of the comparative exhaustion of the localities first fished. The exhaustion has not been complete, as evidenced by the fact that there are few localities in which shelling has ever been undertaken which are not even now the scene of some sort of mussel fishery. This, in fact, is one of the most disturbing features of the situation. If the shellers passed from one region to another, abandoning one nearly exhausted bed after another, and leaving them to recuperate in the course of nature, we would have, practically speaking, a rather effective system of conservation, viz., geographic *rotation of fishery* or a division of the entire territory of fishery into "active" and "resting" regions. The fact that such a system was the result of voluntary movements on the part of those engaged in shelling and not the consequence of legislation, would not make the system any the less effective. As a matter of fact, though, such a practice does not prevail. The body of the fishermen, of course, must leave depleted areas in search of richer fields; but a remnant either of nomadic or of local shellers always remains to carry the process of exhaustion to the very last stage. Furthermore, the greater the scarcity of shells the more persistently the shellers gather and destroy the undersized shells, even those which are far too small to be of any commercial use whatever. The result is that many localities, many streams, are threatened with a condition which is both unnecessary and disastrous—the depletion of the mussel beds to a point where natural recuperation becomes a practical impossibility.

IV. What remedies may be applied?

As in the case of all other fishery resources, the two primary remedies are propagation and protection. Realizing the importance of the mussel resources, and fore-

seeing the impending depletion of such resources, the federal government began an investigation of the mussels more than a dozen years ago. Out of this investigation, after some time, there grew a method of propagation, and this has been put into practice, as yet in a somewhat limited way. It is evident that the work of propagation is bearing fruit in certain regions.

The *protection* of fresh-water mussels is a mode of conservation to which recourse is not yet had in any comprehensive and effective way. One or two states recognize the mussel on their statute books by some sort of law prohibiting a particular apparatus or making a closed season of a few months each year. The states of Minnesota and Illinois passed laws at the latest sessions of their legislatures, which seemed to embody the logical features of a scheme of conservation—a limit on the size of mussels that may be taken (ensuring the continuation of a breeding stock and the earlier abandonment of a depleted bed) and the closure of depleted regions for periods of years, (guaranteeing an opportunity for natural recuperation). The Minnesota enactment was, however, made contingent upon the passage of a similar law by the State of Wisconsin, and, as Wisconsin failed to pass the bill when introduced into its legislature, the Minnesota law remains as yet without effect. The Department of Conservation of Louisiana is understood to be giving serious consideration to the protection and utilization of its mussel resources, and that state has the opportunity to become a leader in giving adequate effect to a plan of conservation of fresh-water mussels.

There appears to be a sort of incongruity in endeavoring to propagate that which we do not regard as of sufficient value to protect. Is it possible that artificial propagation will suffice in itself and make protective restrictions unnecessary? I think we can say, emphatically not. I have always believed that, generally speaking, protection was of greater value than artificial propagation.

It will serve to clear our ideas somewhat to recall that there are a great variety of fresh-water mussels and that

they may be divided, very roughly indeed, into two great classes which are spoken of as short-term breeders and long-term breeders. With the short-term breeders, the early stages of the life-history are completed with great rapidity, the eggs are matured and incubated, and the larvae, or "glochidia," hatch, and, after entering into a state of parasitism on fish, metamorphose into free-living young mussels all within the brief space of a few weeks or months of the summer season. With the long-term breeders, on the other hand, the completion of the corresponding stage of life-history extends over portions of two calendar years: the eggs are matured in the first summer, while the period of incubation extends through the winter and into the following spring. Late in the spring or early in the second summer, the larvae, or "glochidia," become parasitic on fish to complete the metamorphosis and the young mussels enter upon a free-living career at the age of a year, more or less, from the time of maturity of the eggs. They soon begin, however, to make up for lost time; for it is an interesting and remarkable fact that the long-term breeders are relatively rapid growers, while the short-term breeders are very slow in later growth. The quickness of the latter class ends with the start. Familiar representatives of the long-term class are the mucket, fat-mucket and yellow sand-shell, which may attain a market size in four or five years; the niggerhead, pimple-back and blue-point, of the short-term class, require a considerably longer period to become of a substantial size.

Several species of long-term breeders are those which have proven best adapted for artificial propagation. It is as yet doubtful if propagation measures can be applied with practical success to the very valuable mussels of the short-term breeding class.

Assuming then that we shall continue to have propagation without protection, we must look for the following result: The mussels of the more rapid growing species may be continued in the particular waters to which they are adapted and where they may be propagated with

success. The slowly growing species, originally the most abundant and widely distributed, may be reduced to practical extermination and the waters to which they are best adapted will become barren of mussels. We will have lost the half of our resources, rivers and states now productive of mussels will become unproductive, and the industry and the country will have suffered an entirely unnecessary loss.

Protection and propagation may well go hand in hand. They are mutually complementary measures; but certainly the protective measures are those which it seems most inexcusable to neglect.

V. By Whom Can Action Be Taken for the Preservation of Fresh-water Mussels?

The mussels are, naturally, of value to those who find in them a means of livelihood or a source of profit. Such are the shellers and manufacturers distributed through some twenty-five states. It is to be remembered, however, that ownership of the mussels, as of fish, is vested in individuals only after they are captured and removed from the public waters, and this is too late for the exercise of proper measures of protection. Even if actuated by an earnest desire to conduct operations in the most prudent and intelligent way, neither shellers nor manufacturers have the power to exercise the concerted and forceful actions essential for the proper regulation of the fishery.

Ownership of the resources of public waters is claimed by the several states, and it behooves the representatives of the power of these states to unite a feeling of custodianship with an investiture of ownership. The mussel beds are not farmed out, and no responsibilities are delegated to those who work them. The owner of land in fee simple is not only interested in the continued productivity of his holdings, but, if he possesses intelligence, he shapes his plans and his operations to insure an undiminished fertility. The lessee is interested for the period of his lease, or he may be bound by terms that require his

observance of a course of action that looks to an undiminishment of values. When, however, as in the case of nearly all our fishery resources including the mussels, ownership and custodianship are retained by the state, the individuals or corporations whose operations may bring about the diminution of a public resource have not the responsibility nor the power to exercise a just and due restraint over themselves and each other. It is therefore proper that the state should impose and enforce such restrictions as will be for the lasting benefit of all.

Summary and Conclusions.

(1) While fresh-water mussels are found to a limited extent in many foreign countries, their existence in commercial abundance, as far as is now known, is confined to American waters. The fresh-water mussel industries are peculiarly American.

(2) The mussels are important as one of the units that compose our American wealth. They are the basis of a significant fishery, and of industries of manufacture and distribution that are worthy of preservation.

(3) The fresh-water mussel is the paramount material of button manufacture, the use of which has made possible the production of an article of attractive and serviceable qualities, relatively low in price and used by practically every person in the country.

(4) The mussel is by nature self-perpetuative, and, if reasonable care be exercised, danger of exhaustion need not exist. Only by the gross neglect of the necessary measures of protection and propagation will the mussels become so depleted as to be rated no longer a valuable resource.

(5) Up to the present time, protection has been practically neglected, and in most of the streams where important shelling operations have been followed, depletion has not only occurred, but the exhaustive operations are being pushed to the last possible degree.

(6) Shellers and manufacturers should be interested in the perpetuation of a resource that offers them the

basis of livelihood and profit; but the responsibility for preservation of the mussels by proper means rests upon the ultimate owners—the public. Timely and effective action looking to this end can be taken only by the state officials and legislatures.

ON THE RED COLOR OF THE FLESH IN THE SALMONS AND TROUTS

By Professor Edward E. Prince, LL.D., M.A., D.Sc., F.R.S.C., *Commissioner of Fisheries for Canada, Ottawa.*

Various theories have been expounded to explain the characteristic red color of the flesh of salmon and trout, and as all these seem to involve difficulties, in my opinion fatal difficulties, it seems to me that some explanation must be sought to which less objection can be raised.

Is Color Due to Food?

The common view is that the food upon which the fish feed gives the characteristic tint to the flesh. The late Dr. Günther, of the British Museum, emphatically held this view and pointed out that the coloring matter in shrimps and other crustaceans (which turns red when subjected to the digestive fluids, or boiled, or treated with alcohol) is chemically the same as that present in the flesh of salmon and trout. Many authorities could be quoted in favor of this theory, even Dr. Francis Day, in his well-known work on the "British Salmonidæ," refers to it several times; but rather cautiously adds, that it may not be the correct explanation. It is the popular and most widespread view; yet it is almost certainly erroneous. The cases are rare in which the color of the food of any animal directly appears in the muscular tissues. Moose meat is not green though green lily-pads and leafy birch-twigs form so large a part of its food, nor is cariboo meat colored by the pale green moss, which largely furnishes it with nutriment. The ruffed grouse has very white breast-muscles, while in the spruce partridge the color is dark, though both birds live under very similar conditions and are found in the same localities.

Is Color Due to Vascularity?

A second view is that the vascularity of the muscles, the rich blood-supply, explains the color. Pale flesh would mean that the blood vessels were fewer or smaller. Certainly in such Scomberoids as the Tuna (*Thynnus*) the rich provision of blood vessels gives a dark red color to the meat, and accounts too for the high temperature of these fish.

Does Color Signify Health-energy?

Again, the red color it is claimed is a sign of the healthy condition of the fish. Just as a pale complexion may be a sign of ill-health in the human subject, whereas rosy cheeks imply a robust state of health, so a trout or salmon, showing pale-tinted or whitish flesh, is thought to be out of condition. Many anglers and epicures reject such as sick fish. White flesh is regarded as having a pathological significance. A slightly different view is that taken by those who do not regard the pale color as due to sickness or ill-health in the fish; but to poor feed. A well-fed fish in prime condition should, it is claimed by those who adopt this theory, have flesh of a rich red salmon color. Apart from conditions of health, a poorly-fed, starved fish would, according to this view, be lacking in color and wanting in flavor. Many people regard the color as intimately related to flavor and a highly-colored salmon or trout must, in their opinion, have a superior flavor.

Is Color Due to Sexual Ripeness?

Again, the color is associated by many authorities with the ripeness of the fish; that is to say, their reproductive condition. Up to the commencement of spawning it is asserted, salmon and trout accumulate fat, especially the red, oily matter, which during the breeding season is transferred from the muscles to the ovaries and spermaries. There is, no doubt, much ground for holding the view that the red lipochrome is stored up in the muscular tissues. It occurs, indeed, as minute shining bodies

in the small fibrillæ of the muscle fibres, and the same bright-tinted matter occurs, later, in the eggs contained in the ripe female; but a transference of stored materials must also take place in the male salmon, the destination being the spermaries. In the spermaries the red color, however, is lacking, the organs are white, and the ripe contents appear of an opaque, white, creamy color. The purpose of the richly-colored, oily matter in the muscles of the male would not appear, therefore, to be the building up of the white testes, though such might be the explanation of the brilliant red contents of the ovaries.

Other explanations, modifications of the foregoing, have been propounded by various authorities, but all may be summarized under the headings just set forth, viz:

(1) Trophic, and due directly to the food ingested.
(2) Vascular, or produced by the network of blood-vessels.
(3) Incremental, or the reverse, and in the latter case evidence of an unwholesome, possibly pathological, condition of the fish.
(4) Nutrimental or originating in the vigor and well-fed condition of the fish.
(5) Sexual, a storage of fatty matters to meet the demands of reproduction.

Current Views Erroneous.

None of these are fully satisfactory; indeed there are fatal objections to each and all of them. Some of these objections I may here refer to. Thus there is no conclusive proof that the salmon feed exclusively, or even mainly, on shrimps, lobsters, or other crustaceans, in which red lipoid matter occurs abundantly. Many fish with white flesh, or pale flesh, subsist more emphatically on such food than the salmon. In the stomach of such salmon as very occasionally have been captured in the sea, there have been found herring, sand-eels, etc., and any food found inside ascending salmon, in fresh water, consisted of insects, worms and the like, food materials which contain no rich abundance of such coloring matter

as pervades the muscle tissues of salmon and trout. Herring, menhaden and mackerel, though feeding almost solely upon copepods, schizopods, and other small crustaceans, rich in red coloring matters, are not red-fleshed. The chief muscles of the trunk in these fishes are not red, though a thin superficial band of brown muscle extends beneath the skin along each side.* Cod, haddock and other fish with characteristic pale or white flesh, devour much food, like crabs, lobsters, etc., containing red lipochromes, yet their muscles are not tinted in consequence.

Food Does Not Color Muscles Directly.

The occurrence of bright red muscular tissues is very peculiar, and cannot be traced directly to the food in a great many fishes, if indeed in any fishes at all. It is remarkable, for example, that the ancient type of fish, a Palaeozoic type, *Ceratodus,* found in Australia, has deep red flesh, and the name 'Dawson salmon' was given to the Australian *Osteoglossum,* a fish midway between a herring and a salmon, owing to its pink flesh, and edible qualities. Professor Moseley, of Oxford, noticed in dissecting a shark, during the "Challenger" cruise, that while the great muscles of the trunk were pale or white, the superficial muscular layer was a bright red. Professor McMurrich described, I think in *Syngnathus,* the pipe fish, possessing pale muscles, a minute dorsal strip of muscle used in raising or depressing the single dorsal fin as pink or red. The sturgeon has flesh of different colors, red, white, etc., so that it has often been described as "fish, flesh and fowl," (white, red and yellowish). Hence, in view of the fact that white-fleshed fish may feed largely on crustaceans, which are rich in red coloring matters, and that red-fleshed fish by no means feed

*Miss M. I. Newbigin ("Salmon Investigations" Report, Scot. Fishery Board, 1898), observes (p. 162): "The herring feeds habitually on small crustacea, so that it might be said that the pigments of the salmon are obtained indirectly from the herring, which forms its food; but of these pigments there is no reason to believe that the red exists in the herring . . . ., I was unable to find any trace of it, either in the muscle or in the viscera."

uniformly, or mainly, on that type of food; but more commonly on food destitute of such red coloring matter, it is absurd to explain the redness of the muscles in salmon or trout by deriving it specially from color substances in their food. Further, it is a matter of common knowledge that the color in these fishes varies and may be deep or pale, and, indeed, may be absent.

Variability in Salmon Schools.

The fact cannot be ignored that salmon and trout, with white flesh, occur in the same waters, and often mingled in the same schools, with red-fleshed salmon and trout. The large King Salmon, Quinnat, or Spring Salmon of Pacific waters, is normally red-fleshed, often pinkish; but very commonly of a deep red tint; yet white-fleshed examples are common. Those with white flesh are so frequent in the Fraser River that buyers of Quinnat salmon always adopt the practice of having a deep cut made in the shoulder, in order to determine whether it has white flesh or red flesh, the former being unmarketable and rejected accordingly. More curious still is the fact that in quite a number of these salmon the flesh is piebald. The white flesh in such cases is streaked with red, the red masses being mingled, in this way, with the white. Again, in the Sockeye Salmon (also called the Blueback and the Redfish) the muscles are so uniformly of a very deep, bright red, that owing to this constant and uniform color, and a uniformity in size, as well as extreme abundance, it has come to rank as the Pacific Salmon of prime commercial importance.

The great markets of the world do not prefer a pale red salmon; but demand the brilliant deep red, almost vermilion, of the Sockeye salmon's flesh, especially the Fraser River Sockeye caught in Southern British Columbia, Puget Sound, and Juan de Fuca Straits. The Sockeye, and the Spring Salmon (or Quinnat) schools may intermingle. They often come in together from the open sea and ascend the rivers at the same time, and associating in this way, fattening, it may be, upon the same great

feeding grounds in the deep sea, it is difficult to understand why one, the Sockeye, should be so uniformly a rich deep red, while the other, the Quinnat, should vary from a paler red to a light pink or even to a chalky white color.

Curious Case of Sockeye Variation.

But even the Sockeye (so constantly of the attractive deep tint sought by the great markets, and so uniformly small in size as to be perfectly adapted for handling by machinery set to clean, cut up, and rapidly utilize the fish in the canning factories), shows some curious variations. Unusually large examples, nine to twelve pounds weight, may occur, though five to seven pounds would be the general average, and specimens showing striking differences in color are taken. The Sockeye of the northern rivers, the Skeena, Naas, and Alaskan, are usually lighter in color than the Fraser River Sockeye; but one astonishing exception occurs in the north, in a creek not far from the estuary of the Skeena River, viz: a breed of Sockeye salmon quite unlike either of the two types mentioned. This peculiar local variety I have never encountered anywhere else, in all my extensive tours along the Pacific Coast during the last twenty years. It has not the usual vermilion or orange red color, but a deep beef-red tint of rather a dull disagreeable shade. The local canners know well this peculiar variety and have never used it for canning purposes unless there was a shortage of the usual Sockeye Salmon in the Skeena, the Naas, or other northern rivers, and there arose urgent necessity to add a few cases to complete the pack.

Cases of Color Due to Vascularity.

The same dull beef-red color in the flesh of the Tuna is not due, however, to the same cause as in the Sockeye Salmon; but as already pointed out, is due to the unusually rich network of blood-vessels in the great muscles of the trunk. This abundant blood-circulation results in a much higher temperature than that found in the

bodies of most marine and fresh-water fishes, when alive. Dr. John Davy, one of the older British physiological experimenters, (brother of Sir Humphry Davy, who was an authority on the Salmon) made a very exact study of the temperature of the Tuna and other marine fishes, and his researches are even today well worth perusal by all interested in ichthyology.

Color Not the Cause of Flavor.

The fact that Spring Salmon or Quinnat, Sockeye Salmon, Brook Trout, and Lake Trout, may exhibit a deep red color of the flesh, or a paler shade, or in some specimens may even be quite white or yellowish white, shows that the color is not due to a rich supply of blood vessels. Indeed, one species of Pacific Salmon, viz., the Dog Salmon, a very large species, has always whitish flesh, or quite white flesh. As to the contention that loss of color or lack of it, proves an unhealthy, or diseased or deteriorated state, it will not bear examination, for those best acquainted with Pacific Salmon usually consider the white-fleshed specimens as of better flavor than the ordinary red-fleshed salmon.* Personally, I am of opinion that the hard, dry, deep red flesh of the Sockeye has less flavor and is less appetizing than the paler colored Quinnat and the Coho, or the very pale Humpback. The deep red Sockeye is often dry, hard, and lacking in flavor when fresh, but the process of canning or over-cooking, and the addition of a little salt in the can, during the packing, improves very greatly its edible qualities. The Indians of the Pacific Coast always preferred, as more delicate and better flavored, the white Spring Salmon rather than the usual red specimens, and I agree in their opinion; but they also esteemed the white-fleshed Dog-salmon, an opinion in which I do not share.

*The New York *Fishery Gazette* recently said (Vol. XXXIII, No. 48, p. 1,509): "Regardless of the quality of the fish, the color line is sharply drawn by the public when purchasing salmon. The preference, of course, is for fish of a red color, while, as a matter of fact, white salmon is generally a finer fish .... One of the largest handlers of pickled salmon in New York is responsible for the statement that white salmon, as a general rule, is a fancier and better fish than red or pink salmon. .... it is a better fish than most of its deeper colored cousins."

The lake trout, gray trout or Togue, exhibit great variation even in the same lakes and on the same fishing grounds, but some waters are characterized by white-fleshed trout; these latter being as healthy, well-fed and well-flavored as the fish from lakes in which the trout are uniformly tinted pink or red.

If we compare the various Pacific with the Atlantic Salmon, the latter, it may be said, are generally paler. Yet no one would claim, I think, that the Atlantic Salmon is inferior to any of the Pacific species in edible qualities, flavor, texture or delicacy; indeed most people would affirm that the Atlantic Salmon, the Labrador, Saguenay, Gaspe, Restigouche, Miramichi, St. John, or other fine Canadian fish, are very much superior. Moreover, these Atlantic fish differ in the color of the flesh locally, and some practical fishermen claim that they can determine the river from which a fish comes not only by its shape, average size, and build; but by the color, texture, and special flavor, of the meat. As there are white grapes which are just as good as red or rich black grapes, so the white-fleshed salmon and trout may be quite equal to the deeply tinted varieties. An hotel proprietor informed me recently that if red trout or salmon, and pale-fleshed trout or salmon, were placed on the same tables, the guests, without exception, would choose the deep colored fish, and would declare that it was superior in flavor. On the other hand, sweet corn, if white (or even bleached artificially), would also be pronounced better and more delicate than the yellow-colored corn. This shows how small is the value of popular opinion, while the shade of red, or the tint, of the flesh, would seem in so many salmon and trout to be very erratic, there is general agreement that after spawning, all red-fleshed specimens are paler, the colored oily matter passing, it is contended, to the eggs.

Color Transferred to Eggs.

No very exact observations are on record, however, but this deterioration can hardly take place in the male

fish, inasmuch as the contents of the testes are of an intense opaque white and no transference of red material has apparently taken place from the muscles to those organs at the breeding season. It is not true to say of all red-fleshed salmon that the red color is associated with the building-up process, or storing of reserve materials, preparatory to the spawning period. That would not apply to white-fleshed salmon or trout, and does not appear to apply to the male, even in the species with deep red flesh. Undoubtedly the red oily matter, abundant in the flesh, does pass to the ovaries of the female, and the eggs are brilliantly tinted by these abundant red globules in the yolk-matter. It is interesting to note that red eggs and pale or white living eggs are familiar to hatchery officers, the red eggs being the product of red-fleshed fish, and the white or colorless eggs being the product of pale-fleshed females. Pale eggs of white-fleshed salmon and trout are almost as colorless as the eggs of the whitefish. What an important point this is in the work of fish culture. The red-fleshed fish are universally preferred, yet we often breed from pale-fleshed parents. The greatest care should be taken to take eggs from females characterized by the highly-esteemed, deep red tint in the flesh.

Theoretical Explanation of Color.

How does this red color arise? What is the explanation of its presence? I dealt with the question over twenty years ago in a paper in the Annals of Natural History, the title being "The Presence of Oleaginous Spheres in the Yolk of Teleostean Ova," and I claimed that the color of the flesh was an hereditary trait, and I there pointed out that, if Professor F. M. Balfour's view be correct, that the ova of Teleosteans had ancestrally diminished in size, then the fluids, such as myosin, lecithin, etc., contained in the vitelline globe of the egg, would diminish also. If all the contents did not diminish equally; but in some species, a phosphorized oily fluid, like lecithin, did not decrease proportionately, droplets

or globules would accumulate, and remain in the ovum. If these globules were tinted by some excretionary or other pigments, they would appear as striking, though unessential and redundant, features in the egg. Now, the colored globules in the eggs of the salmon bear precisely this character. In many other fish eggs, one or many large colored globules or spheres occur, and they are not used up as the embryo fish develops, but persist for a long time after the young larva is hatched, and may even be seen in the transparent or semi-transparent body of the fish in the post-larval stages. It seems to me that the color of the salmon's flesh originates in these red globules, which continue from generation to generation as redundant and unessential elements in the ovum and embryo, and remain to permeate the muscles in the alevin, smolt, grilse, and adult stages in the life of the fish. Were this orange-colored fluid absolutely necessary to the health and life of the salmon and trout, the pale or white-fleshed fish would not exist; they would die out. But such is not the case. In some lakes and streams these less desirable trout, less desirable because white-fleshed, have superseded the red-fleshed type.

It must be noted that the clear, somewhat translucent, fluid in the ripe ovary, and bathing the eggs, gives as experiment has shown, marked proteid reactions; it is rich in lecithin; no less than 15 to 20 per cent, and yields also nucleo-proteins.

Colored Globules Do Not Cause Buoyancy in Eggs.

In studying the development of marine fishes, especially those with pelagic eggs, I have found that the globules in the vitelline globe whether colored, as in some species, or uncolored as in other species, had nothing to do with their buoyancy or floating power, though many authorities have so claimed, for the eggs of the cod and haddock float in the sea, while destitute of those remarkable globules, as freely as the eggs of the cunner or sea perch (*Tautogolabrus*) or the mackerel (*Scomber*) in which a colored globule or several globules, form

a very conspicuous feature in the living egg. The eggs of the herring and the skulpin exhibit a large number of such globules, but have no floating power.

Chemistry of Yolk-Color.

The real nature of this red-colored material apart from Miescher's and Hoppe-Seyler's early studies has never been chemically determined thoroughly.* We know that in the orange vitelline globe of the hen's egg (the yellow yolk-ball) 11% or 12% consists of a lipoid, which the best authorities regard as lecithin; but some recent workers, amongst them Dr. A. Erlandsen, have disputed this, and tried to isolate cuorin from the yellow yolk, but did not succeed. Serons and Palozzi, in further researches, emphasized again the presence of the characteristic lipoid, lecthin; though the yellow pigment itself is a xanthophyll, really regarded by Willstatter and Escher as an animal pigment called carotin-lutein, or lutein with a carotin-like pigment in its substance.

Practical Bearing on Fish-Culture.

The answer to the question "Why are Salmon and Trout Red-Meated?" would therefore seem to be, that it is an hereditary feature, due almost certainly to the colored material in the yolk of the egg from which the fish developed. This colored material is unessential; it persists as "oil drops" until a late stage in the early life of the fish and is not used up, as the other contents of the egg are; but finally it passes into the body-tissues, and is found in the form of very minute bright red bodies, seated in the cement substance of the individual fibrillæ of the great lateral muscles. That these colored bodies are absent in some trout and salmon, and present in others of the same species, demonstrates that they are

*Miescher's researches are incomplete and inconclusive, and further studies are urgent. Miss Newbigin surmised (*op. cit.*, p. 161), that the red color was a lipochrome pigment allied to tetronerythrin or zoonerythrin, and in the salmon is important in coloring the ova . . . . In the male salmon the pigment is probably eliminated as the fat is used up, (*vide*, p. 164).

not vitally essential. While, therefore, a salmon or trout, with pale flesh or white flesh, is by no means inferior, yet popular taste gives the bright orange-colored meat the preference. Hence the necessity of breeding from red-meated fish, and rejecting those which are not red-meated. The former produce the red- or orange-colored eggs from which the desirable red-meated salmon, or trout, can alone be hatched.

DESTROYING A FOOD PRODUCING INDUSTRY

IS IT SOUND PUBLIC POLICY?

By Henry C. Rowe, *Groton, Conn.*

Over forty years ago the State of Connecticut was foremost among all the states in permitting her enterprising citizens to create an oyster farming industry. During the past ten years, she has by unwise legislation taken the lead toward its destruction.

Between 1876 and 1880, it was conceded that Connecticut had taken the lead in the oyster industry and the most progressive legislators from other states came here to ascertain Connecticut methods and to advocate similar measures in their respective states.

Between 1870 and 1880, the laws of Connecticut permitted certain officials in the coast towns to grant to any citizen, areas of land under water for the purpose of propagating and planting shell fish; they were sold to such citizens at $1.00 per acre.

For many years the enterprise was regarded as too hazardous for extensive investment, but in 1874 and '75, the more enterprising oyster planters purchased some of the barren grounds in the open waters of Long Island Sound, from one to three miles from land, outside of the bays, harbors and islands where the previous oyster cultivation had existed.

These adventurous planters were ridiculed for such a hare brained investment and it was commonly spoken of as a case of "A fool and his money soon parted." Notwithstanding many losses, dangers and difficulties, these adventurous planters achieved success and before 1878 the enterprise was recognized as a promising and growing industry and was rapidly developed and extended. Oysters at that time within these waters grew more rapidly and the meats were much better than in the same areas at the present time.

By 1881, the towns along the coast had realized large sums of money with but little expense by selling oyster grounds to the planters, in pursuance of the laws then existing authorizing such sales. For instance, prior to 1881, the town of Stratford received clear of all expense, $5,600 on a sale of about six thousand acres.

This industry having proved a success, the legislature in 1881, created a Commission so that the state instead of the towns should receive the proceeds of the sales of the grounds. It was provided that this Commission might sell oyster grounds for the same price at which the towns had previously been authorized to sell, and the Commission in pursuance of this new legislation procured an office, held frequent meetings and employed a clerk and an engineer.

If the business of the state had been administered upon the same economical methods as that of the towns had been, the state should have received net proceeds to the amount of $45,000 on the sales of the next seven years. But on investigation in 1888, it was found that the business of the state had been transacted in so extravagant a manner that instead of netting $45,000, the state had lost $45,000.

A summary of the official reports showed the following figures:

Cost of Commission, its employees and expenses to June, 1888		$84,647.15
Total proceeds sales of ground and engineering same	$57,091.00	
Deduct for worthless ground returned to the state	18,247.40	38,843.60
Net loss to state		$45,803.55

At a legislative investigation in 1888, it appeared that each meeting of the Commission cost the state thirty dollars, and that their pay was drawn, according to the reports of the Commissioners, for nearly every week-day of the year. Also that the expenditures for the Clerk of Shell Fisheries and the Engineer were of extravagant proportions, so that, although the oyster growers had paid the state over $57,000 for grounds, instead of net proceeds there was a loss of over $45,000.

In the meantime, however, the oyster industry had grown very rapidly up to the time of the inception of the Commission in 1881, and from that time until 1885 the growth continued, although at a much slower rate, until about 1890. This was not *because* of any encouragment or assistance by the Commission, but rather *in spite* of the hindrance and obstructions created by it.

From 1876 until somewhat later than 1890, the business was prosperous and profitable, and to a much less degree it remained so between 1890 and 1900.

With the increase of the quantity of oysters in Connecticut waters, it has been found that the growth of the oysters has very much diminished and the meats are as a rule not as well nourished. Whether these results are attributable to a diminution of the food and shell material in the water owing to the great increase in the quantity of oysters, or whether it is due to various other causes which have been suggested, is not yet perhaps definitely decided.

As oysters furnish food to the star-fish, the increase in this food has at various times much increased the number of star-fish, so that great expense has been entailed to catch and destroy them. In addition to natural causes, there are other reasons why the industry in the State of Connecticut is now steadily declining and the acreage of oyster grounds held by planters in the state has greatly decreased in recent years.

One of the most depressing influences has been the unjust and unreasonable taxation of oyster grounds.

Prior to 1893, the law with reference to the taxation of the franchises for oyster grounds, was that the grounds should be assessed at their fair market value, and should pay a tax of ten mills upon this valuation. The basis for this taxation was that oyster farming was analogous to farming on land. Both are food producing and both depend upon the propagation and planting of crops by the farmer. In both, the crops must be protected and cared for, and must be harvested and marketed when they arrive at maturity, if not lost during the five years of growth required for oysters.

When this law was enacted, it appeared that the average tax upon farm lands of the state was about ten mills on actual market values, and as oyster farming was more hazardous than up-land farming, and, as the property involved was less protected by law than property on land, it was considered that ten mills was a sufficient and reasonable rate of taxation. The taxation of oyster grounds was analogous to that of farms, rather than to that of city property, because the oyster grounds could not partake of the benefits of taxation such as are derived by city property,—they need no fire protection; no sewers or public works of my kind; no street lights; no building department; no educational expense, parks, street pavements, sidewalk pavements, etc. All these items furnish reasons for the additional taxes which in many cities amount to twenty mills instead of ten mills, as upon farms in the country.

In 1893 it was called to the attention of the legislature that the oyster grounds situated from one to four miles from land, in the open waters of Long Island Sound, were of necessity more subject to depredation than any property on land, because the navigable waters are a lawful highway which is travelled by every kind of boat and vessel by night and by day.

After a long discussion in the General Assembly, it was enacted that five mills additional should be collected in taxes upon the oyster grounds, and the Shell Fish Commissioners were authorized to expend this amount in oyster police for the protection of the oysters on these exposed grounds.

The Shell Fish Commission, whose personnel had been changed after the investigation of 1888, called a consultation of oyster growers of the state, and methods were devised for the expenditure of this additional tax in such ways as seemed to the oyster growers and to the Commissioners best adapted to protect these properties.

This continued for eighteen or twenty years, after which without any authority of law or justice, the amounts collected for this purpose were withheld and the

oyster growers were deprived of the protection for which they had paid additional tax.

In 1908 a movement was started by certain politicians, upon the assumption that the taxes upon the oyster properties were not as much as they ought to be. The reason advanced for this claim was that the oyster grounds did not pay to the state nearly as much revenue per acre as the oyster grounds in Rhode Island.

In a message to the Legislature by the Governor at that time, this was pointed out, but the message failed to mention the basic fact that in Rhode Island the oyster grounds are owned by the state, while in Connecticut the state sold the ground upon prices and terms fixed by itself and that they are owned by the planters,—so that, while in Rhode Island the state may justly fix such a rental as it may choose upon its own property, the State of Connecticut has no right to exact a rental on property that it does not own, but is justly entitled to a reasonable tax upon the value of property owned by the oyster farmers. The message also failed to note the fact that some of the grounds in Rhode Island are beyond comparison more valuable than those in Connecticut, but, even so, it has been found in recent years that the rent required in Rhode Island is so high, that the business is now steadily declining in that state, as well as in Connecticut.

Misled by incorrect information, the legislatures during the past four years, have added one hardship after another in the treatment of the oyster farmers.

While the law permits the assessment of oyster grounds at their market value, they have been made in fact, ten and twenty times as much as they were ten years ago. Oyster grounds that have been assessed at $5,000 have been publicly offered for sale for $500, or even $250.

The oyster farmers have been wrongly deprived of many thousands of acres of land under forms of law, by means of making the assessments so high that the owners were compelled to give up their lands rather than pay the

exorbitant taxes. These lands were bought for cash from the state, and taxes were paid upon them for thirty years, but they were practically robbed from their owners.

The same official who in 1908 assessed a piece of ground at between eight and nine thousand dollars assessed it in 1914 for $128,938, more than fourteen times what he had assessed it at in 1908. The rule of assessment according to law on both of those dates, was the "fair market value," and it was worth much less in 1914 than in 1908.

This is only one illustration of many hundreds in which oppresive injustice was inflicted upon the oyster farmers. But not only was the law violated with reference to assessments, but the rate of taxation has been doubled so that it is now twenty mills on the dollar of valuation, and oyster grounds three miles from land that can enjoy none of the protection or benefits of city government, are required to pay a revenue at the same rate as real estate in the centre of a populous city.

The oyster growers have been unjustly deprived of the police which they paid for by special tax, and have been compelled to go to each legislature and deny and refute misrepresentations intended to procure additional legislation against them. They have been harassed and persecuted by short-sighted politicians, so that a large number of those formerly engaged in the business have abandoned it entirely, others have sold out their interests, and many of the leading firms have removed their business partly or wholly from the state and their capital is being transferred to other lines of investment.

I will not take space here to enumerate the many annoying and oppressive laws which have been enacted in recent years. This short-sighted policy is the latest exhibition of "killing the goose to get the golden egg."

Farmers on land are encouraged and assisted by federal and state appropriations of many millions of dollars annually. Swimming fish are propagated for the benefit of the fisherman and the angler at great expense by both state and federal governments.

Is it then public policy to discourage the oyster farmer, who at great labor and expense produces his own crops without assistance?

The excuse has been made that the oyster industry has been prosperous and profitable. It was so twenty-five or thirty years ago, but it does not appear that it should be penalized for prosperity which has long since past, or that it should be driven out of the state by reason of such departed prosperity.

Is it public policy to discourage any food producing industry when our city population is increasing many times as fast as our farming population? When consumers are multiplying and food supply is decreasing? Is it not against the interest of every consumer that food producers should be discouraged when the price of food is already so high?